# Astronomy 5830 – Observed Properties of Astronomical Systems

Autumn Semester 2017

Homework #4 – Due December 4, 2017

1. SDSS QSO composite. Download the SDSS composite QSO spectrum (available in ASCII and FITS format) from the class website and use these data to complete the sections below. I suggest you use `splot` in IRAF for these measurements, although there are a wide variety of options (you could even write your own routine, although deblending is nontrivial). Provide an approximate estimate of the uncertainties in these quantities.

    a. Create a plot of the QSO composite and label Hα, Hβ, Lyα, CIV, CIII], and the [OIII] and [NII] doublets. See Tables 5.1 and 6.1 of the text for the wavelengths of these features.

    b. Measure the equivalent widths of these lines (or blends of lines) and estimate the ratios of [NII] λ6583 to Hα and [OIII] λ5007 to Hβ. Comment on how you handled any blended features.

    c. Measure the velocity width of Hβ and [OIII] λ5007. How do these measurements compare?

2. Estimates of the physical parameters of the BLR provide useful constraints on the properties of the clouds. For a typical Seyfert galaxy reasonable estimates are that the filling factor $\varepsilon=10^{-7}$, covering fraction $f=0.1$, mass $M_{BLR}=0.01\ M_{\odot}$, and radius $R_{BLR}=8$ light days.

    a. Assume the BLR clouds are uniformly distributed within the broad line region $R=R_{BLR}$. What is the characteristic size $l_c$ of a BLR cloud [in cm]?

    b. How many BLR clouds $N_c$ are there?

    c. Given the inferred mass of the BLR, what is the density per cloud [in g $cm^{-3}$]? Is this consistent with the particle density inferred from line ratios?

    d. Qualitatively discuss how the assumptions that go into the estimate of the covering fraction affect the inferred density. A few sentences should suffice.

    e. Qualitatively discuss how the assumptions that go into the estimate of the filling factor affect the inferred mass of the BLR. A few sentences should suffice.